NATURAL RESOURCES CONSERVATION SERVICE

VIRGINIA CONSERVATION PRACTICE STANDARD

GRADE STABILIZATION STRUCTURE

(No.)

CODE 410

DEFINITION

A structure used to control the grade and head cutting in natural or artificial channels.

SCOPE

This standard applies to all types of grade stabilization structures, including a combination of earth embankments and mechanical spillways and full-flow or detention-type structures. This standard also applies to channel side-inlet structures installed to lower the water from a field elevation, a surface drain, or a waterway to a deeper outlet channel. It does not apply to structures designed to control the rate of flow or to regulate the water level in channels. (Refer to Virginia Conservation Practice Standard, *Structure for Water Control (Code 587)*.

PURPOSE

To stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.

CONDITIONS WHERE PRACTICE APPLIES

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. Special attention shall be given to maintaining or improving habitat for fish and wildlife where applicable.

DESIGN CRITERIA

The structure must be designed for stability after installation. The crest of the inlet must be set at an elevation that stabilizes upstream head cutting.

EMBANKMENT DAMS

Class (a) dams that have product of storage times the effective height of the dam of 3,000 or more, those more than 35 feet in effective height, and all class (b) and class (c) dams shall meet or exceed the requirements specified in Technical Release No. 60 (TR-60).

Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an effective height of 35 feet or less shall meet or exceed the requirements specified for ponds. (Refer to Virginia Conservation Practice Standard, *Pond (Code 378.)*

The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

POND SIZE DAMS

If mechanical spillways are required, the minimum capacity of the principal spillway shall be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in Table 1, less any reduction because of detention storage.

If the effective height of the dam is less than 20 feet and the emergency spillway has a stable grade throughout its length with no overfalls and has good vegetation masking its reentry into the downstream channel, the principal spillway capacity may be reduced but can be no less than 80 percent of the 2-year frequency, 24-hour duration storm.

If criteria values exceed those shown in Table 1 or the storage capacity is more than 50 acre-ft, the 10-year frequency, 24-hour duration storm must be used as the minimum design storm.

Grade stabilization structures with a settled fill height of less than 15 ft and 10-year frequency, 24-hour storm runoff less than 10 acre-ft, shall be designed to control the 10-year frequency storm without overtopping. The mechanical spillway, regardless of size, may be considered in design and an emergency spillway is not required if the combination of storage and mechanical spillway discharge will handle the design storm. The embankment can be designed to meet the requirements for Virginia Conservation Practice Standard, *Water and Sediment Control Basin (Code 638)* rather than the requirements for Virginia Conservation Practice Standard, *Pond (Code 378).*

FULL-FLOW OPEN STRUCTURES

Drop, chute, and box inlet drop spillways shall be designed according to the principles set forth in the Engineering Field Manual for Conservation Practices, the National Engineering Handbook, and other applicable NRCS publications and reports. The minimum capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration showing Table 2, less any reduction because of detention storage. If site conditions exceed those shown in Table 2, the minimum design 24-hour storm frequency is 25 years for the principal spillway and 100 years for the total capacity. Structures must not create unstable conditions upstream or downstream. Provisions must be made to ensure reentry of bypassed storm flows.

Toe wall drop structures can be used if the vertical slope is 4 feet or less, flows are intermittent, downstream grades are stable, and tail water depth at design flow is equal to or greater than one-third of the height of the overfall.

The ratio of the capacity of drop boxes to road culverts shall be as required by the responsible road authority or as specified in Table 2 or 3, as applicable, less any reduction because of detention storage, whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

ISLAND-TYPE STRUCTURES

If the mechanical spillway is designed as an island-type structure, its minimum capacity shall equal the capacity of the downstream channel. For channels with very small drainage areas, the mechanical spillway should carry at least the 2-year, 24-hour storm or the design drainage curve runoff. The minimum emergency spillway capacity shall be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 2 for total capacity without overtopping the headwall extensions of the mechanical spillway. Provision must be made for safe reentry of bypassed flow as necessary.

SIDE-INLET DRAINAGE STRUCTURES

The design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown in Table 3. The minimum principal spillway capacity shall equal the design drainage curve runoff for all conditions. If site condition values exceed those shown in

Table 3, the 50-year frequency storm shall be used for minimum design of total capacity.

LANDSCAPE RESOURCES

In highly visible public areas and those associated with recreation, careful considerations should be given to landscape resources. Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat. Exposed concrete surfaces may be formed to add texture or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

GENERAL CRITERIA

Earth embankment and emergency spillways of structures for which criteria are not provided under the Virginia Conservation Practice Standard *Pond (Code 378)* or in TR-60 must be stable for all anticipated conditions. If earth spillways are used, they must be designed to handle the total capacity flow indicated in Tables 2 or 3 without overtopping the dam. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for anticipated flow conditions. Discharge from the structure shall be sufficient that no crop damage results from flow detention.

Necessary sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic cleanout.

The earth embankment pond structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life. Protective guardrails, warning signs, fences, or lifesaving equipment shall be added as needed.

If the area is used for livestock, the structures, earthfill, vegetated spillways, and other areas should be fenced as necessary to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

PROTECTION

The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction shall be seeded or sodded as necessary to prevent erosion. If climatic conditions preclude the use of vegetation, nonvegetative covering such as gravel or other mulches may be used.

CONSIDERATIONS

- Consideration should be given to the effects of grade stabilization structures on volumes and rates of runoff, evaporation, deep percolation and groundwater recharge.
- Effects of the structure on soil water and resulting changes in plant growth and transpiration should be considered.
- Ability of structure to trap sediment and sediment-attached substances carried by runoff should be assessed.
- Consider the effect of the structure on the susceptibility of downstream streambanks and streambeds to erosion.
- Effects of the proposed structure on the movement of dissolved substances to groundwater should be evaluated.
- Consideration should be given to the effects of grade stabilization structures on visual quality of water resources.

Table 1. - Design criteria for establishing minimum capacity of the principal spillway for dams with storage capacity of less than 50 acre-feet and a good emergency spillway site.

Maximum drainage area for indicated rainfall*			Effective height of dam	Frequency of min. design, 24-hour duration storm
0-3 in	3-5 in	5+ in		
----------Acres----------			ft	yr
200	100	50	35 or less	2
400	200	100	20 or less	2
400	200	100	20-35	5
600	400	200	20 or less	5

* In a 5-year frequency, 24-hour duration storm

Table 2. - Design criteria for establishing minimum capacity of full-flow open structures.

Maximum drainage area for indicated rainfall			Vertical drop	Frequency of minimum design, 24-hour duration storm	
				Principal spillway capacity	Total capacity
0-3 in	3-5 in	5+ in			
----------acres----------			ft	yr	yr
1,200	450	250	5 or less	5	10
2,200	900	500	10 or less	10	25

* In a 5-year frequency, 24-hour duration storm.

Table 3. - Design criteria for establishing minimum capacity of side-inlet, open weir, or pipe-drop-drainage structure.

Maximum drainage area for indicated rainfall*			Vertical drop	Frequency of minimum design, 24-hour duration storm	
				Receiving channel depth	Total capacity
0-3 in	3-5 in	5+ in			
----------acres----------			ft	ft	yr
1,200	450	250	0-5	0-10	-----
1,200	450	250	5-10	10-20	10
2,200	900	500	0-10	0-20	25

* In a 5-year frequency, 24-hour duration storm.

PLANS AND SPECIFICATIONS

Plans and specifications for installing grade stabilization structures shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

Specified materials shall provide stability, durability, and safety characteristics required to achieve the planned objective.

Grade stabilization structures within the scope of TR-60 shall be constructed according to the guide specifications in the National Engineering Handbook, Section 20.

Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical.

Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution will be minimized and held within legal limits. All work will be conducted in a skillful and workmanlike manner.

SPECIFICATIONS FOR INSTALLATION OF STRUCTURES WITHIN THE SCOPE OF VIRGINIA CONSERVATION PRACTICE STANDARD, *POND (CODE 378)*

Foundation Preparation

The foundation area shall be cleared of trees, logs, stumps, roots, brush, boulders, sod and debris. Where needed to establish vegetation, the topsoil and sod are to be stockpiled and spread on the completed structure. Foundation surfaces shall be sloped to no steeper than 1:1. The foundation area will be thoroughly scarified before placement of the fill material. The surface will have moisture added or be compacted if necessary so the first layer of fill material can be compacted and bonded to the foundation.

The cutoff trench (where necessary) and any other required excavations shall be excavated to the lines and grades shown on the plans or as staked in the field. To the extent they are suitable, excavated materials are to be used in the permanent fill.

Existing stream channels in the foundation area shall be sloped no steeper than 1:1 and deepened and widened as necessary to remove all stones, gravel, sand, stumps, roots and other objectionable material and to accommodate compaction equipment.

Foundation areas shall be kept free of standing water when fill is being placed on them.

Fill Placement

The material placed in the fill shall be free of detrimental amounts of sod, roots, frozen soil, stones over 6 inches in diameter (except for rock fills), and other unsuitable material.

Drainfill shall be kept from being contaminated by adjacent soil materials during placement by either placing it in a cleanly excavated trench or by keeping the drain at least one foot above the adjacent earthfill.

Selected backfill material shall be placed around structures, pipe conduits and antiseep collars at approximately the same rate on all sides to prevent damage from unequal loading.

Fill material shall be placed, spread, and compacted beginning at the lowest point of the foundation and then brought up in horizontal layers of such thickness that the required compaction can be obtained. The fill shall be constructed in continuous horizontal layers except where openings or sectionalized fills are called for. In those cases, the slope of the bonding surfaces between embankment in place and embankment to be placed will not be steeper than 2.5 horizontal to 1 vertical. The bonding surface is to be treated the same as that specified for the foundation so as to ensure a good bond with the new fill.

The distribution and gradation of materials shall be such that there will be no lenses, pockets, streaks, or layers of material

differing substantially in texture or gradation from the surrounding material. Where it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream portions of the fill. Where zoned fills are specified of substantially differing materials, the zones shall be placed according to lines and grades shown on the drawings. The complete work shall conform to the lines, grades and elevations shown on the drawings or as staked in the field.

Moisture Control

The moisture content of the fill material shall be such that the required compaction can be obtained. Material that is too wet shall be dried to meet this requirement and material that is too dry shall have water added and mixed until the requirement is met.

Compaction

The movement of the hauling and spreading equipment over the fill shall be controlled so that the entire surface of each lift shall be traversed by not less than one tread track of the equipment or compaction shall be achieved by a minimum of four complete passes of a sheepsfoot, rubber tired or vibratory roller.

When a minimum required density is specified, each layer of fill shall be compacted as necessary to make the density not less than that specified.

Fill adjacent to structures, pipe conduits and antiseep collars shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually directed power tampers or place vibrators. Compaction adjacent to concrete structures will not be started until the concrete has attained sufficient strength to support the load.

Protection

A protective cover of vegetation shall be established on all exposed surfaces of the embankment, spillway and borrow area. In some cases, temporary vegetation may be used until conditions are right for establishment of permanent vegetation. The embankment and spillway shall be fenced unless domestic animals do not have access to the area.

Seedbed preparation, seeding, fertilizing, and mulching shall comply with the Virginia Conservation Practice Standard *Critical Area Planting (Code 342)*.

Principal Spillways

Pipe shall conform to the appropriate specifications suitable for the intended purpose. Corrugated Polyethylene Drainage Tubing and Corrugated Polyethylene Pipe may be used in addition to those pipe materials recognized for pond construction. Antiseep collars are to be of materials compatible with the pipe and installed so as to be watertight. The pipe shall be installed in accordance with the manufacturer's instructions. The pipe shall be firmly and uniformly bedded throughout its length and shall be installed to line and grade as shown on the drawings. Principal spillways for structures without suitable emergency spillway sites shall carry the minimum design storms shown in Table 4 after storage considerations.

Table 4. - Minimum spillway capacity where there is no emergency spillway site.

Drainage Area	Height of dam[2]	Storage	Minimum design Storm[1] Frequency	Minimum Duration
Acre	ft	acre-ft	yr	hr
<15	<20	<50	10	24
<20	>20	<50	25	24
>20	<20	<50	25	24
All others			50	24

[1] Select rain distribution based on climatological region.

[2] Top of dam elevation minus low dam toe elevation.

Concrete

Concrete shall receive the detail in mix design and testing consistent with the size and requirements of the job. Mix requirements or necessary strength should be specified. Type of cement, air

entrainment, slump, aggregate or other properties are to be specified where necessary. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner. Necessary curing should be specified. Reinforcing steel is to be placed as indicated on the plans and held securely in place during concrete placement. Subgrades and forms are to be installed to line and grade and the forms are to be mortar tight and unyielding as the concrete is placed.

Foundation and Embankment Drains

Foundation and embankment drains, when required, will be placed to line and grade as shown on the drawings. Detailed requirements for drain material and any required pipe will be shown in the drawings and specifications for the job.

Flood Storage

Crop damage shall not result from detention storage.

Appropriate safety measures such as warning signs and safety barriers will be specified.

The completed job shall present a workmanlike appearance.

DESIGN AND CHECK DATA REQUIREMENTS FOR STRUCTURES UNDER THE SCOPE OF VIRGINIA CONSERVATION PRACTICE STANDARD *POND (CODE 378)*

Design Data

1. Soil investigation logs and notes. Form NRCS-538 may be used.

2. Record survey notes and other pertinent data to include topographic survey or location sketch.

3. Document complete design data.

4. Compute earth fill volume (if needed).

Check Data

1. Profile along centerline of completed embankment and emergency spillway using the same benchmark and stationing of the original survey.

2. At least one cross-section of completed embankment showing station, top width, and side slopes.

3. Sufficient cross-sections to define dimensions and elevations of the emergency spillway.

4. Dimensions and elevations of principal spillway. Record type of materials used.

5. A statement that the following have been satisfactorily completed:

   a. Establishment of vegetation by practice specifications.

   b. Fencing as required by practice specifications.

   c. Installation of safety devices.

OPERATION AND MAINTENANCE

The operation and maintenance plan for grade stabilization structures shall address:

- The embankment and outlet structures shall be inspected annually, as a minimum. They shall also be inspected after major storm events.

- Damage to the embankment and outlet structures shall be repaired immediately.

- Woody vegetation will be removed from the embankment.

- Damage to the embankment from burrowing animals will be repaired and the animals shall be removed.

REFERENCES

1. Series 700 Specifications, VA, NRCS.

2. Engineering Field Manual.

3. TR-60.

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GRADE STABILIZATION STRUCTURE

Approved Practice Narrative

(No.)

CODE 410

410 D1 Grade Stabilization Structure: A grade stabilization structure shall be installed to stabilize the grade and control erosion in natural or artificial channels, to prevent the formation or advance of gullies, and to enhance environmental quality and reduce pollution hazards.